AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

1 of 1

(CLASSIFICATION)

HW-SB-6

SERIES AND COPY NO.

DATE
November 1, 1960

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

X

THIS DOCUMENT CONTAINS INFORMATION
RELAYED IN THE ATOMIC ENERGY ACT OF 1954.
NO TRANSMITTAL OF THE DISCLOSURE OF ITS
CONTENTS IN ANY MANNER TO ANY UNAUTHORIZED
PERSON IS PERMITTED.

TITLE

Welding Development Program, Resistance
Projection Welding of Zircaloy -2 to
Natural Uranium and Resistance Seam
Welding of Zircaloy -2 to Zircaloy -2 to
Zircaloy -2

AUTHOR

Sciaky Bros., Inc.

Research Division
Los Angeles

ISSUING FILE COPY
RECEIVED 300 AREA

1960

RETURN TO

OTHER OFFICIAL CLASSIFIED INFORMATION

THIS MATERIAL CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECS. 793 AND 794, THE TRANSMISSION OR REVELATION OF WHICH IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

THIS DOCUMENT MUST NOT BE LEFT UNATTENDED OR IN THE HANDS OF AN UNAUTHORIZED PERSON. NO ACCESS TO IT, WHEN NOT IN USE, IT MUST BE STORED IN AN APPROVED LOCKED REPOSITORY. IF AN APPROVED GUARDED AREA WHILE IT IS YOUR RESPONSIBILITY AND UNTIL YOU HAVE OBTAINED A SIGNED RECEIPT FOR CLASSIFIED FILES, IT IS YOUR RESPONSIBILITY TO KEEP IT AND ITS CONTENTS WITHIN THE LIMITS OF THE SUBJECT AND FROM ANY UNAUTHORIZED PERSON. ITS TRANSMISSION, AND STORAGE AT YOUR PLACE OF RESIDENCE IS PROHIBITED. IT IS NOT TO BE DUPLICATED. IF ADDITIONAL COPIES ARE REQUIRED, OBTAIN THEM FROM THE ISSUING FILE. ALL PERSONS READING THIS DOCUMENT ARE REQUESTED TO SIGN IN THE SPACE PROVIDED BELOW.

[illegible]

(CLASSIFICATION)

DECLASSIFIED

DECLASSIFIED

HW-SB-6

This Document Consists Of

Page(s)

Engineering Report

WELDING DEVELOPMENT PROGRAM
RESISTANCE PROJECTION WELDING OF
ZIRCALOY -2 TO NATURAL URANIUM
AND RESISTANCE SERIES SEAM WELDING OF
ZIRCALOY -2 TO ZIRCALOY -2 TO ZIRCALOY -2

PROJECT 6-0-817

FOR

HANFORD ATOMIC PRODUCTS OPERATION

OF

GENERAL ELECTRIC COMPANY

RICHLAND, WASHINGTON

DISTRIBUTION:

Copies 1, 2, 3

R.S. Bell
Attn: T.B. Correy
General Electric Company
Hanford

Copy 4, Sciaky Bros., Inc.
File

Classification Cancelled and Changed To

DECLASSIFIED

By Authority of D.S. Lewis

PR-24 4-19-94

By G.E. Sawley 5-18-94

Verified By Jessie Mally,
5-18-94

OCTOBER 28, 1960

SCIAKY RESEARCH DIVISION

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DECLASSIFIED

DECLASSIFIED

HW-SB-6

SCIACY

WELDING DEVELOPMENT PROGRAM
RESISTANCE PROJECTION WELDING OF
ZIRCALOY -2 TO NATURAL URANIUM
AND RESISTANCE SERIES SEAM WELDING OF
ZIRCALOY -2 TO ZIRCALOY -2 TO ZIRCALOY -2
PROJECT 6-0-817

INTRODUCTION

Discussions presented in this report result from product development activity conducted for the Hanford Atomic Products Operation of General Electric Company, Richland, Washington, by the Research Division, Sciaky Bros., Inc., 2311 Purdue Avenue, Los Angeles 64, California, under General Electric Company Contract No. DDR-96.

Program objective, discussion of development effort, and test results are presented with a summary of final weld schedule, conclusions, and recommendations.

PROGRAM OBJECTIVE

The objective of the development effort was to define the optimum projection weld area configuration and the weld schedule required to consistently resistance projection weld join a machined Zircaloy -2 end closure (ring with projection/s) to the exposed (depressed) surface of a natural uranium tube clad (or contained within a double wall) Zircaloy -2 tube assembly and to further process said assemblies by series seam welding the outer Zircaloy -2 clad wall to the Zircaloy -2 end closure simultaneously with the weld joining of the Zircaloy -2 end closure to the inner Zircaloy -2 clad wall.

Applicable drawings of pertinent portions of the components and assembly are presented elsewhere in this report.

WELDING MACHINES, ELECTRODES, AND TOOLING

Welding Machine - Projection

Sciaky PMCO.7STK, 600 KVA, with Dekatron controls.

Welding Machine - Seam Weld (Series)

Sciaky PMM.2TCK, 250 KVA, with Dekatron controls.

DECLASSIFIED

DECLASSIFIED**ELECTRODES - Projection**

Upper - 2-1/2-inches diameter RWMA Class III copper with weld face radius of 20-inches, water cooled.

Lower - Collet of RWMA Class III copper machined to specifications peculiar to sustaining tooling.

ELECTRODES - Series Seam Welds

Upper - 1-1/2-inches diameter RWMA Class III copper with weld face radius of 1-inch, weld track width 1/8-inch, internal water cooling.

Lower - 1-1/2-inches diameter RWMA Class II copper with weld face radius of 2-inches, weld track width 1/4-inch, internal water cooling.

TOOLING

The accompanying photograph 1 shows the lower electrode (collet), spacers, and units comprising the part confining tooling required for mounting on the lower horn of the welding machine. In the order of assembly; items 1 through 4 are of RWMA Class III copper. Item 1 is a spacer to aid in sustaining the pressure imposed on item 2 when the assembly is clamped to the welding machine lower arm cap (See photograph 2). Item 3 is a spacer to assure proper location and seating of the taper of collet item 4. This item is the lower electrode proper as well as a device for tightly gripping the Zircaloy -2 tubing and maintaining proper position during welding. The required clamping action of item 4 is obtained by placing item 5 over the collet and screwing item 6 onto the threaded portion of item 2. Items 5 and 6 are of non-magnetic stainless steel.

WELD MATERIAL

Weld material was supplied to Sciaky by the General Electric Company, Hanford Atomic Products Operation, Richland, Washington.

TUBE ASSEMBLY - Short

Natural Uranium metal tubing clad with Zircaloy -2 tubing 2.460-inch O.D. by 1.850-inch I.D. by 1/2-inch long with ends cut square and parallel (Uranium tube flush with ends of cladding tubes).

TUBE ASSEMBLY - Long

Same as above except assemblies were approximately 2-inches overall cladding tube length and the Uranium tube contained within was, at one end, recessed to a depth approaching 1/2-inch (to permit series seam welding at closure area).

DECLASSIFIED

DECLASSIFIED

HW-SB-6

SCIAKY

CLOSURE

Rings of Zircaloy -2, approximately 2.420-inch O.D. by approximately 1.890-inch I.D. by 1/2-inch thick.

DEVELOPMENT ACTIVITY

General - Development of a final optimum weld schedule and verification thereof required special attention to the following:

Projection Welds

- a. Recording of machine function: Traces were made of machine function throughout the program.
- b. Contamination: Removal of foreign materials from parts prior to projection weld assembly by immersion of Zircaloy -2 clad natural Uranium tube in constantly agitated solution of HNO_3 (50 - 60%) at 50 - 60° C for 1-minute. Rinse in distilled water, air dry in dust free area.

Etch; Solution of HNO_3 and HF at 25 - 35° C for 1-minute. Rinse in methanol followed by distilled water, air dry in dust free area.

Etch Formula:

40% by volume of 70% HNO_3
5% by volume of 49% HF
55% distilled water

Argon gas purging of the weld area before and during projection welding. This operation was to keep parts discoloration and oxidation to a minimum.

- c. Set Down: Although the magnitude of set down (a function of prime import to projection welding) was not restricted to obtain an overall assembled parts dimension, nevertheless, sufficient attention was given to this necessary weld procedure to assure uniform set down and therefore consistent weld quality.
- d. Development Testing: Weld joints were subjected to consistent testing by macrosection observation, tear testing, and visual inspection for excessive forge-out. Consistency and continuity of welds and lack of deleterious porosity were so ascertained.

Series Seam Welds

- a. Recording of machine function: Traces were made of machine function throughout the program.

DECLASSIFIED

DECLASSIFIED

SCIAPY

- b. Contamination: No requirement for processing other than initial done at time of projection welds as seam welding was done immediately after projection welding.
- c. Development Testing: Weld joints were subjected to consistent testing by macrosection observation, tear testing, and visual inspection.

All components received and subsequently used during the development program were returned to the Hanford Atomic Products Operation of General Electric Company, at Richland, Washington, regardless of final condition, i.e., destructively tested development assemblies and complete assemblies.

FINAL CLOSURE CONFIGURATION AND FINAL WELD SCHEDULES

PROJECTION AND SERIES SEAM WELDS

Final Configuration, Projection/s of Closure

An accompanying drawing-chart gives the general configuration and dimensions of all projections/designs used during development. Noted thereon are the two projection configurations considered best, i.e., A-33 as first choice, A-31 as second choice.

FINAL WELD SCHEDULES

Projection Welds, Closures

Weld Phase Shift (%)	97
Pre-heat	
Phase Shift (%)	60
Impulses (cycles)	1
PQ-2 Top Pressure	26
PQ-1 Back Pressure	18
Weld Pressure (lbs.)	4439
Constant Pressure (hi-low)	Constant Low
Heat (cycles)	5
Weld (impulses)	1
Cool (cycles)	5.5
Squeeze (cycles)	1000
Hold (cycles)	251
Forge Delay (tenths) initial	5.5
Transformer Connection	Parallel

Welding was conducted with weld area enclosed in argon gas atmosphere.

DECLASSIFIED

DECLASSIFIED

HW-SB-6

SCIAKY

Series Seam Welds, Cladding Tubes to Closure

Weld Phase Shift (%)	65
PG-1 Top Pressure (lbs.)	1200
PG-2 Back Pressure (lbs.)	700
Weld Pressure (lbs.)	500
Constant Pressure (hi-low)	Constant Low
Heat (cycles)	1
Weld (impulses)	1
Cool (cycles)	0.5
Drive	Intermittent
Motor Speed (RPM)	50
Motor Rotation (cycles)	16
Squeeze (cycles)	50
Hold (cycles)	50
Forge Delay (tenths) initial	5.5
Transformer	Parallel

CONCLUSIONS

The excellent results attained adequately demonstrate the feasibility of projection resistance welding a Zircaloy -2 (ring type) closure to a tube of natural Uranium enclosed within (or clad) two tubes of Zircaloy -2 and the subsequent joining of the closure to the physically confining Zircaloy -2 tubes (extending above the Uranium area) by resistance series seam welding.

RECOMMENDATIONS

As a result of this preliminary feasibility study and weld development program it is recommended that the work be continued to attain the best possible series seam weld condition and the absolute ultimate in the resistance projection weld joining of the Zircaloy -2 closure to the natural Uranium tubes. Such is attainable and can be perfected to such degree that the application of the process will be entirely practical as a production method.

DECLASSIFIED

DECLASSIFIED
HW-SB-6

1. Exploded View - Lower Electrode and Support Device Parts

DECLASSIFIED

DECLASSIFIED

HW-SB-6

2. Tooling Installed on Welding Machine

DECLASSIFIED

DECLASSIFIED

HW-SB-6

3 - Seam Weld Zircaloy -2 to Zircaloy -2.

Etchant: HF, 2 parts; HNO_3 , 2 parts; glycerine, 6 parts.
Reagent.

4 - Series Seam Welded Zircaloy -2 Tube to Zircaloy -2 Closure to Zircaloy -2 Tube and Projection Welded Zircaloy -2 Closure to Natural Uranium Tube.

Etchant: HF, 2 parts; HNO_3 , 2 parts, glycerine, 6 parts.
Reagent.

DECLASSIFIED

DECLASSIFIED

HW-SB-6

STEP 1 PROJECTION WELD

STEP 2 SERIES SEAMWELD

DECLASSIFIED

DECLASSIFIED

HW-SA-6

SCIaky

SKETCH NO.	X	Y	Z	PROJ.	F	B	W	K	A	
A-1	.088	.044	.525	3	.017	.010R	.030	.032	.250	
A-2	.062	.0315	.525	4	.017	.010R	.030	.032	.250	
A-3	.062	.0315	.256	4	.017	.010R	.030	.032	.250	
A-4	.062	.0315	.300	4	.017	.010R	.030	.032	.250	
A-5	.066	.022½	.400	4	.017	.003	.021	.045	.250	
A-6	.066	.036	.400	4	.017	.010R	.020	.042	.250	
A-7	.066	.036	.319	4	.017	.010R	.020	.042	.250	
A-8	.066	.036	.301	4	.017	.010R	.020	.042	.250	
A-9	.062	.0315	.300	4	.017	.010R	.030	.032	.250	
A-10	.062	.0315	.301	4	.017	.010R	.030	.032	.250	
A-11	.062	.0315	.260	4	.017	.010R	.030	.032	.250	
A-12	.055	.040	.525	4	.015	.015 **	.015	.040	.250	
A-13			.525	*					.250	
A-14	Rev.	.062	.040	.251	4	.015	.015 **	.015	.040	.250
A-15	Rev.	.062	.040	.440	4	.015	.015	.015	.040	.250
A-16	Rev.	.062	.040	.481	4	.015	.015	.015	.040	.250
A-17	Rev.	.062	.040	.404	4	.015	.015	.015	.040	.250
A-18	Rev.	.062	.040	.396	4	.015	.015	.015	.040	.250
A-19	Rev.	.062	.040	.420	4	.015	.015	.015	.040	.250
A-20	Rev.	.062	.040	.409	4	.015	.015	.015	.040	.250
A-21	Rev.	.062	.040	.414	4	.015	.015	.015	.040	.250
A-22	Rev.	.062	.040	.439	4	.015	.015	.015	.040	.250

DECLASSIFIED

DECLASSIFIED

SCIaky

SKETCH NO.		X	Y	Z	PROJ.	F	B	W	K	A
A-23	Rew.	.062	.040	.366	4	.015	.015	.015	.040	.250
A-24	Rew.	.062	.040	.365	4	.015	.015	.015	.040	.250
A-25	Rew.	.015	.005	.359	18	.015	.005**	.015	36°	.250
A-26	Rew.	.016	.010	.360	16	.010	.010**	.010	.006	.250
A-27	Rew.	.062	.040	.447	4	.015	.015	.015	.040	.250
A-28	Rew.	.062	.040	.429	4	.015	.015	.015	.040	.250
A-29	Rew.	.062	.040	.395	4	.015	.015	.015	.040	.250
A-30	Rew.	.062	.040	.345	4	.015	.015	.015	.040	.250
A-31	New	.062	.040	.527	4	.015	.015	.015	.040	.250
A-32	New	.155	.040	.540	***	.015	.015	.015	.150	.250
A-33	New	.155	.040	.540	***	.015	.015	.015	.150	.250
A-34	New	.242	.000	.540	***	.015	.008	.015	.220	.250
A-35	New	.145	.040	.540	***	.015	.025	.025	.120	.250
A-36	New	.165	.040	.540	***	.015	.020	.020	.130	.250
A-37	Rew.	.158	.040	.540	***	.015	.012	.012	.146	.250
A-38	Rew.	.155	.040	.250	***	.015	.015	.015	.140	.250
A-39	New	.165	.035	.540	***	.015	.015	.015	.150	.250
A-40	New	.165	.035	.300	***	.015	.015	.015	.150	.250

* No projection, 2-inch R. on weld face.

** Square

*** 2 (outer and inner)

Note: Projection design considered best is A-33, projection design A-31 is considered next best.

DECLASSIFIED

**DATE
FILMED**

9 / 26 / 94

END